

**REMARKS**

This is intended as a full and complete response to the Office Action dated July 13, 2007, having a shortened statutory period for response set to expire on October 13, 2007. Please reconsider the claims pending in the application for reasons discussed below.

**ELECTION/RESTRICTION**

The Applicants acknowledge the restriction of claim 60. Claim 60 is cancelled without prejudice. The Applicants reserve the right to file divisional/continuation applications to prosecute the non-elected subject matter.

**CLAIM REJECTIONS****35 U.S.C. §103(a) Claims 8-9 and 37-44**

Claims 8-9 and 37-44 stand rejected as being unpatentable over *Miura* (U.S. Patent Publication No. 2003/0155247) in view of *Dubin* (U.S. Patent No. 6432821) and further in view of *Wang* (U.S. Patent No. 6528412). The Applicants respectfully disagree.

Independent claim 8 recites elements not taught or suggested by the combination of *Miura*, *Dubin* and *Wang*. As discussed in the previous response filed on June 28, 2007, *Miura* teaches using a conductive seed layer disposed on a substrate prior to a copper electroplating deposition process to provide enough required electric current to enable the copper electroplating deposition process. See Paragraph 13, Lines 6-9 and paragraph 14, lines 7-9. The conductive seed layer is formed by PVD or CVD. See Paragraph 50, Lines 3-6. *Miura* does not teach or suggest directly depositing a copper seed layer on a barrier layer.

In particular, the Examiner asserts on Page 4 of the Office Action dated July 13, 2007, stating that in a closer look, the electrochemically deposited seed enhancement layer 130 is deposited directly on the diffusion barrier material 121, citing Figure 5 of *Miura*. The methods recited in claims 8, 20 and 31 are open to depositing a copper seed

layer by CVD or PVD prior to exposing the substrate to a first copper solution. The Applicants respectfully disagree.

The Applicants respectfully submit that the electrochemically deposited seed enhancement layer 130 is reinforcing and adding thickness to an existing copper seed layer disposed on the substrate, not directly depositing a seed layer on a barrier layer. In contrast, *Miura* teaches that a prior deposited copper seed (deposited by CVD or PVD process) must be present to enable the subsequent electrolytic copper plating process. The Applicants respectfully submit that the present application are not open to deposit a copper seed layer by CVD or PVD prior to exposing the substrate to a first copper solution, as asserted by the Examiner, because the first copper solution is arranged to electroplating a seed layer directly onto a barrier layer.

Enclosed please find a declaration under 37 C.F.R. § 1.132 of Aron Rosenfeld. Mr. Rosenfeld has a Bachelor of Science from McGill University, a Masters from Harvard University, and a PhD from Queen's Collage in Solid State Physics. Mr. Rosenfeld also was Principal Scientist and Program Manager both in Surface Technology, Alcan International Ltd, from 1997-2002 prior to working for Applied Materials, Inc. At Applied Materials, Mr. Rosenfeld held the positions of Technology Director, Electrochemical Plating Division, from July 2002 to May 2006 and Chief Technology Officer, Electrochemical Plating Division from July 2006 until May 2007. As noted by Mr. Rosenfeld, *Miura's* teaching of seed layer preservation process cannot be interpreted as a process for direct depositing a seed layer on a barrier layer, as listed in item 5 of the declaration. The Applicants submit that the seed layer preservation process as taught by *Miura* requires an existing copper seed layer deposited on a barrier layer to enable the subsequent bulk copper plating process, not as a process for direct depositing a seed layer on a barrier layer as claimed in the present application .

Since *Miura* specifically teaches the subsequent electrolytic copper plating process cannot be performed without the electric current provided through the seed layer, *Miura* can not teach or suggest electrolytic copper plating of seed layer, as asserted by the Examiner.

*Dubin* teaches using multiple steps to electroplating copper on a seed layer. The multiple steps electroplating copper process has an initial step to repair discontinuities in the copper seed layer. Similar to the teaching of *Miura* discussed above, neither *Dubin* nor *Miura*, alone or in combination, teaches or suggests depositing a copper seed layer onto a barrier surface by an electroplating process, as claimed in the present application.

*Wang* teaches CVD or ALD depositing an adhesion skin layer on a barrier layer on a substrate. Subsequently, an electroplating process, e.g., a wet process, may be performed to deposit a seed layer on the adhesion skin layer. Therefore, the seed layer as taught by *Wang* is deposited on an adhesion skin layer particularly chosen to match the seed layer for promoting adhesion between the layers. The seed layer as taught by *Wang* is deposited on a specifically selected adhesion skin layer, not on a barrier layer. The seed layer as taught by *Wang* is not deposited on a barrier layer.

The Examiner asserts that *Wang* teaches forming the seed enhancement layer 130 by ECD and then plating copper fill 132 from the seed enhancement layer 130 and the seed layer 122. However, the embodiment cited by the Examiner is recited in Figure 4-5 of *Wang*, noted as "Prior art", teaching the seed layer 122 is deposited by a PVD process. *Wang* does not teach or suggest directly depositing a copper seed layer onto a barrier surface by an electroplating process. As noted by Mr. Rosenfeld in item 6 of the declaration, *Wang's* teachings cannot be interpreted as a process for direct depositing a seed layer on a barrier layer. As well known in the art, the seed layer repair process (of Figure 4-5 as indicated by the Examiner) will provide copper ions to bridge over holes or discontinuity in the existing copper seed layer rather than directly depositing a copper seed layer on a barrier layer.

Accordingly, in the closer look of Figures 4-5 of *Wang* as indicated by the Examiner, the copper ions will bridge over holes or discontinuity in the existing copper seed layer rather than directly depositing a copper seed layer on a barrier layer, as asserted by the Examiner. Therefore, the Applicants respectfully submit that the combination of *Miura* in view of *Dubin* and further in view of *Wang* would not yield the present invention.

Thus, the Applicants submit that independent claim 8, and all claims depending therefrom, are patentable over *Miura* in view of *Dubin* and further in view of *Wang*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

### **35 U.S.C. §103(a) Claim 10**

Claim 10 stands rejected as being unpatentable over *Miura* in view of *Dubin*, and further in view of *Wang* and *Nagai* (U.S. Patent No. 6709563). The Applicants respectfully disagree.

Independent claim 8 recites elements not taught or suggested by the combination of *Miura*, *Dubin*, *Wang* and *Nagai*. The patentability of claim 8 over *Miura*, *Dubin*, and *Wang* has been discussed above. *Nagai* teaches a plating liquid containing divalent copper ions, a completing agent and an optional pH adjusting agent. However, there is no teaching or suggestion from *Nagai* that would suggest to one of ordinary skill in the art to modify *Miura*, *Dubin*, and *Wang* in a manner that would yield depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by claim 8.

Thus, the Applicants submit that claim 10, that depends from claim 8, is patentable over *Miura* in view of *Dubin* and further in view of *Wang* and further in view of *Nagai*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

### **35 U.S.C. §103(a) Claims 20-21 and 45-52**

Claims 20-21 and 45-52 stand rejected as being unpatentable over *Miura* in view of *Dubin*, and further in view of *Wang*. The Applicants respectfully disagree.

As discussed, the combination of *Miura*, *Dubin* and *Wang* does not teach or suggest depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by independent claim 21. As such, a *prima facie* case of obviousness has not been established as the references fail to teach each claimed elements.

Thus, the Applicants submit that claim 20, and claims 21 and 45-52 depending therefrom, are patentable over *Miura* in view of *Dubin* and further in view of *Wang*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

**35 U.S.C. §103(a) Claim 22**

Claim 22 stands rejected as being unpatentable over *Miura* in view of *Dubin* and further in view of *Wang* and *Nagai*. The Applicants respectfully disagree.

As discussed, the combination of *Miura*, *Dubin* and *Wang* and *Nagai* does not teach or suggest depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by independent claim 20, from which claim 22 depends from. As such, a *prima facie* case of obviousness has not been established as the references fail to teach each claimed elements.

Thus, the Applicants submit that claim 22, that depends from claim 20, is patentable over *Miura* in view of *Dubin* and further in view of *Wang* and in view of *Nagai*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

**35 U.S.C. §103(a) Claims 31-32 and 53-58**

Claims 31-32 and 53-58 stand rejected as being unpatentable over *Miura* in view of *Dubin* and further in view of *Wang*. The Applicants respectfully disagree.

As discussed, the combination of *Miura*, *Dubin* and *Wang* does not teach or suggest depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by independent claim 31. As such, a *prima facie* case of obviousness has not been established as the references fail to teach each claimed elements.

Thus, the Applicants submit that independent claim 31, and claims 32 and 53-58 depending therefrom, are patentable over *Miura* in view of *Dubin* and further in view of *Wang*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

**35 U.S.C. §103(a) Claim 33**

Claim 33 stands rejected as being unpatentable over *Miura* in view of *Dubin* and further in view of *Wang* and *Nagai*. The Applicants respectfully disagree.

As discussed, the combination of *Miura*, *Dubin* and *Wang* does not teach or suggest depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by independent claim 31, from which claim 33 depends. As discussed above, *Nagai* does not bridge the deficiencies of the combination of *Miura*, *Dubin* and *Wang*. As such, a *prima facie* case of obviousness has not been established as the references fail to teach each claimed elements.

Thus, the Applicants submit that claim 33, that depends from claim 31, is patentable over *Miura* in view of *Dubin* and further in view of *Wang* and in view of *Nagai*. Accordingly, the Applicants respectfully request the rejection be withdrawn.

**35 U.S.C. §103(a) Claim 59**

Claim 59 stands rejected as being unpatentable over *Miura* in view of *Dubin* and *Wang*, and further in view of *Dubin* ('217) (U.S. Patent Publication No. 2004/0108217). The Applicants respectfully disagree.

As discussed, the combination of *Miura*, *Dubin* and *Wang* does not teach or suggest depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by independent claim 31. *Dubin* ('217) teaches electroplating a copper layer for metal interconnection. However, there is not teaching or suggestion from *Dubin* ('217) that would suggest to one of ordinary skill in the art to modify *Miura*, *Dubin* and *Wang* in a manner that would yield depositing a copper seed layer onto a barrier surface by an electroplating process, as recited by claim 59. As such, a *prima facie* case of obviousness has not been established as the references fail to teach each claimed elements.

Thus, the Applicants submit that independent claim 59, is patentable over *Miura* in view of *Dubin* and further in view of *Wang* and further in view of *Dubin* ('217). Accordingly, the Applicants respectfully request the rejection be withdrawn.

**CONCLUSION**

Thus, for at least the reasons discussed above, the Applicants submit that all claims now pending are in condition for allowance. Accordingly, both reconsideration of this application and its swift passage to issuance are earnestly solicited.

If, however, the Examiner believes that any unresolved issues still exist, it is requested that the Examiner telephone Mr. Keith Taboada at (732) 530-9404 so that appropriate arrangements can be made for resolving such issues as expeditiously as possible.

Respectfully submitted,

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